



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

NADS - Nuclear And Atomic Data System

M. S. McKinley, B. Beck, D. McNabb

September 22, 2004

International Conference on Nuclear Data
Santa Fe, NM, United States
September 26, 2004 through October 1, 2004

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

NADS – Nuclear And Atomic Data System

Michael S. McKinley; Bret Beck; Dennis McNabb

Lawrence Livermore National Laboratory

Abstract. We have developed NADS (Nuclear and Atomic Data System), a web-based graphical interface for viewing pointwise and grouped cross-sections and distributions. Our implementation is a client / server model. The client is a Java applet that displays the graphical interface, which has interactive 2-D, 3-D, and 4-D plots and tables. The server, which can serve and perform computations the data, has been implemented in Python using the FUDGE package developed by Bret Beck at LLNL. Computational capabilities include algebraic manipulation of nuclear evaluated data in databases such as LLNL's ENDL-99, ENDF/B-V and ENDF/B-VI as well as user data. Processed data used in LLNL's transport codes are accessible as well. NADS is available from <http://nuclear.llnl.gov/>.

INTRODUCTION

Nuclear cross section data represents some of the fundamental information fed into nuclear reactor and weapon computer codes. Understanding this data and the variations of the data among the different databases is a key concern for users of these codes. This presents a need for a nuclear and atomic data browser that is powerful and user-friendly.

For graphical browsing, there are several implementations. Web forms and hyperlinks were the first type of implementation. However, the options for this implementation are cumbersome and result is a static image. This type of data browsing may be currently found at Brookhaven National Laboratory (<http://www.nndc.bnl.gov/>) and Los Alamos National Laboratory at (<http://t2.lanl.gov/data/ndviewer.html>).

Another implementation is a stand alone or client-server program with interactive plotting. This gives the advantage of more powerful processing of data and better GUI controls. JANIS¹ is one project that has had success with this type of implementation. Nuclear and Atomic Data System (NADS), developed at LLNL, represents another data browser that displays the ENDL² formatted data in a user-friendly and powerful environment.

Fortunately, two other projects, recently completed at LLNL, were able to feed into the new NADS system. The first was FUDGE (For Updating Data

and Generating ENDL), which had been previously developed by Bret Beck. FUDGE is a Python code that can read and process pointwise ENDL formatted data. FUDGE was extended to become a server for the pointwise ENDL data by sending out XML formatted commands to the NADS Java applet. The second project was the translation of ENDF/B formatted cross sections into pointwise ENDL format. This allows for new evaluations such as ENDF/B-V, ENDF/B-VI³, JEFF⁴, and JENDL⁵ to be served along with ENDL 94 and ENDL 99 data.

Starting NADS

The only requirement for NADS is an Internet connection and a Java 1.4.1+ enabled browser. Connect with a web browser to <http://nuclear.llnl.gov/> and select the "Plot Nuclear Data (NADS)" button in the upper left of the web page to startup NADS. Clicking on "First Time Users FAQ" will open a web page that explains issues that first time users may encounter.

Advanced options like saving, loading, and copying to the clipboard are violations of security by default in Java. The Java permission file needs to be adjusted to enable these actions. The steps describing how to accomplish this is given in the "First Time Users FAQ" mentioned above.

Once NADS starts up, it automatically connects to the server. Once connected, the “Data Tree Viewer” pops up as a new window. NADS displays information as a series of hidden panes that are accessible by clicking on tabs at the bottom. A “Help” menu is available to give additional information about controls and functionality.

DATA TREE VIEWER

The data viewer shows the data as a collection of branches (which contain other branches or leaves) and leaf (which are endpoints) nodes in a tree representation as shown in Figure 1. At the top level, evaluated or processed data branches may be chosen. Evaluated target options are embedded in the tree that allow for cross sections to be heated up to different temperatures. The next level down is the database name such as “endl99” or “endfb5r2.” In Figure 1, “endl94” was chosen.

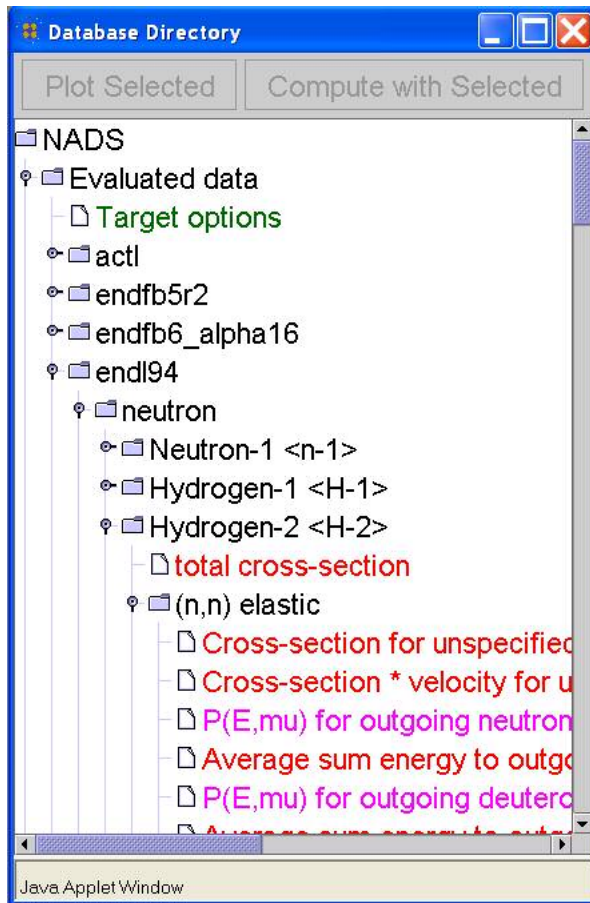


FIGURE 1. Data tree view which shows a few evaluated databases. Processed data is below and off the screen.

Selecting the database yields a list of incident particles for that database, which is a neutron in the example. ENDL data has incident particles such as photons, neutrons, electrons and helium nuclei. The next level of the tree shows the target nucleus. The example displays a deuteron for the target. Going down further yields the cross section and other data for each reaction channel.

The processed data is used in deterministic particle transport codes and varies by the input parameters fed to it. It follows the same tree structure as the “Evaluated Data” and is a sibling branch of the tree. However, since it represents data used by processing codes, input parameters are used to determine the output of the data. The input parameters may be set by double clicking the “Collapsing Options” in the tree.

Data may be plotted by double clicking on the data leaf or by highlighting a selection and clicking on the “Plot Selected” button.

DATA TABLES

Every time data is plotted, the pointwise values are stored in a table. Data in a table may be modified and replotted. Users may copy and paste data to other spreadsheet or text programs. In addition, data can be saved to and loaded from a tab delimited text file. Beside each table is a button that allows for the data to be used in computations as described below.

2-D PLOTTING

Data that appears as red in the Data Viewer may be plotted to an interactive 2-D plot. By default, plotting data with the same axis labels will place them on the same plot. If the axis labels are different, a new plot will be created. This behavior may be changed through preferences.

Initially, the legend, title, and axis labels surround the plot. The location and size are controlled by the Java layout manager. Removing the legend or changing the size of text will automatically reposition everything. This may be overridden by manually dragging or resizing elements around the page.

Plot property may be changed in a dialog window by right-clicking the plot or by selecting “Chart Options” from the “Data” menu. Font, visibility,

legend layout and other attributes may be controlled in the property dialog.

Right-clicking also allows for one element to be placed before or behind another element. Clicking and dragging in the plot allows for zooming in and out. Plots may be copied as graphic files, saved or printed.

3-D & 4-D PLOTTING

Data that appears as pink and blue are 3-D and 4-D data, respectively. Double clicking or selecting them and clicking "Plot Selected" will render a plot for each set of data.

Controls such as zoom in, rotate, rescale, etc are located next to the plot. Users may click and drag to rotate the plot by hand. Double clicking in the plot moves the plot. Plots may be modified with the "Chart Options" menu. In addition, they may be saved, copied or printed.

A 4-D plot is the same as a 3-D plot except that the 4th dimension is treated as "time." A 4-D plot may be played through as an animation or just stepped through one value at a time with the controls. A scale button is available to redraw the plot so it zooms in on the data at the current "time" step.

COMPUTATIONS

Having FUDGE power the server allows for NADS to draw on some of its features. One important feature is the ability to do computations with the data. Some examples are

1. A macroscopic cross section can be constructed by multiplying the cross section by isotopic densities.
2. A cross section can be divided by another to see the relative changes.
3. A Gaussian bump can be added to a cross section.
4. Cross sections from several databases can be averaged..

Computations are set up by first assigning variables to data. In the "Data Viewer", data may be added by selecting leaf nodes and clicking the "Compute with Selected" button. This assigns a symbol to the data in the "Computations" window. Selecting more than one set of data at a time results in the sum being assigned to a variable. User data made in tables may also be added by clicking on the "Send to Computation" button.

The computation dialog (see Figure 2) allows for an equation to be entered using the variables shown in the symbol column. Simple single valued answers are displayed immediately in a popup dialog. All other results are plotted and stored in a table. See "Computations" in the help menu for a list of functions and operations available for data.

Results from computations may be stored as a variable for cleaner equations. In addition, computation sessions may be saved and loaded.

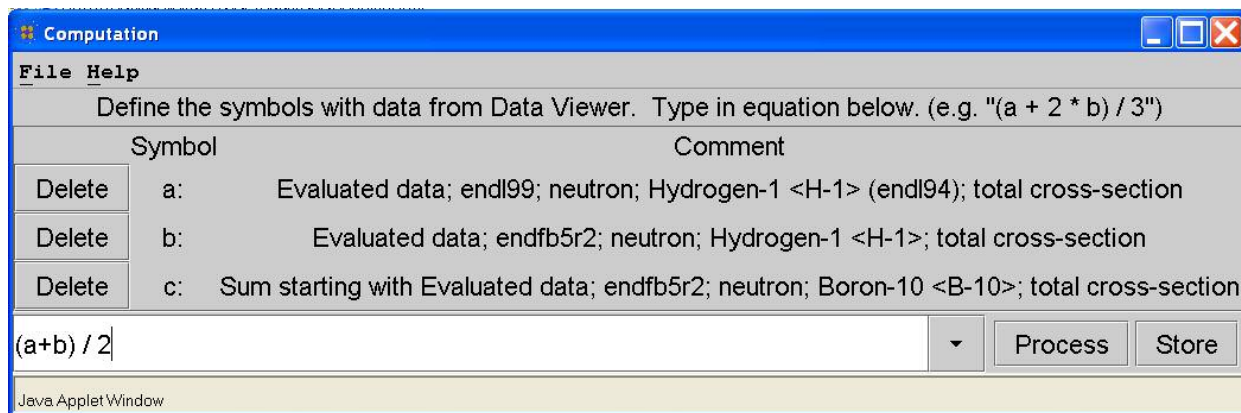


FIGURE 2. NADS Computation window example showing the averaging of two cross sections from different databases.

California, Lawrence Livermore National Laboratory
under contract No. W-7405-Eng-48.

FUTURE WORK

NADS development is an ongoing project with many features planned for the future. The following is a list of future enhancements to NADS:

1. Add uncertainties to data and 2-D plots.
2. Synchronize tables and plots so modifying one immediately modified the other.
3. Add free floating text and arrows to 2-D plots.
4. Increase server stability to overcome occasional loss of port problem.
5. Speed up FUDGE with Numerical Python
6. Add search functionality.
7. Add experimental EXFOR⁶ data.

ACKNOWLEDGMENTS

This work was performed under the auspices of the U.S. Department of Energy by the University of

REFERENCES

1. Java-based Nuclear Information Server (JANIS), developed by the OECD Nuclear Energy Agency and Aquitaine Electronique Informatique, available at <http://www.nea.fr/janis/>.
2. Howerton, R. J., MacGregor, M. H., "The LLL Evaluated Nuclear Data Library (ENDL): Description of Individual Evaluations for Z=0,98," Lawrence Livermore National Laboratory Report UCRL-50400 Vol. 15 (1978).
3. US Evaluated Nuclear Data Library, ENDF/B-VI, Release 8 - Produced by the Cross Section Evaluation Working Group, released in October 2001, available at www.nndc.bnl.gov/csewg/.
4. Joint Evaluated Fission and Fusion General Purpose File, The JEFF-3.0 General Purpose Library, Produced by the OECD Nuclear Energy Agency (NEA) Data Bank in April 2002, available at http://www.nea.fr/html/dbdata/projects/nds_jef.htm.
5. Shibata, K., et al., "Japanese Evaluated Nuclear Data Library Version 3 Revision-3: JENDL-3.3," *J. Nucl. Technol.* **39**, 1125 (202).
6. EXFOR Systems Manual, Brookhaven National Laboratory, BNL-NCS-63330 (1999).